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PHILOSOPHICAL TRANSACTIONS.

Munday, April 8. 1667.

The Contents.

Directions for Observations and Experiments to be made by Masters of Ships, Pilots, and other fit Persons in their Sea-Voyages; Printed with Enlargements and Explications of what was formerly publisht of this Kind; suggested partly by Sir. R. Moray, partly by Mr. Hook; as, the severall wayes of Observing, both at Sea and Land, the Declinations and Variations of the Needle: Some ways of knowing the different Gravities of Sea-water: A Form of a Scheme, representing at one view, to the eye, Observations of the weather for a whole Month, &c.

DIRECTIONS

For Observations and Experiments to be made by Masters of Ships, Pilots, and other fit Persons in their Sea-Voyages.

THough the Art of Navigation, one of the most useful in the World, be of late vastly improved, yet remain their many things to be known and done, the knowledg and performance whereof, would tend to the accomplishment of it: As the making of exact *Maps* of all Coasts, Ports, Harbors, Bayes, Promontories, Islands, with their severall Prospects and Bearings; Describing of Tydes, Depths, Currents, and other things considerable in the Seas: Turnings, Passages, Creeks, Sands, Shelves, Rocks, and other dangers: Nice Observations of the Variations

and Dippings of the Needle, in different places, and in the same place, at different times: The Winds, Weather, and Tempers of the Seasons every where: The great Depths, Ground, and Vegetables at the bottom of the Sea: The various Degrees of Saltness of the Sea-water, in several places, and at several Depths at the same place. If besides Astronomical things, to be hereafter lookt into, the following Experiments be carefully made, and Directions observed by as many Ingenious Persons, as have opportunity, it may fairly be hoped, that from multitudes of Experiments and Observations, such Rules may be framed, as may be of inestimable use for Seamen. To which purpose the *Royal Society*, having some years ago, ordered that Eminent Mathematician Master *Rooke*, one of their Fellows, and *Geometry* Professor of *Gresham Colledge* (since deceased, to the great detriment of the Common-wealth of Learning) to draw up some Directions for Seamen, the better to capacitate them for making such Observations abroad, as might be pertinent and suitable to the purposes above-mentioned, such Directions were drawn up accordingly, and soon after printed in *Num.* 8. of these *Transactions*. But, further to encourage and facilitate the Work of those, that shall be engaged to put them into practice, it was thought fit, that what of this Kind was heretofore but barely proposed, should now be published with ample and particular Explanations, and considerable Additions; which done, a good number of such printed Copies is, by the Care, and at the Expences of the *R. Society*, to be lodged with the Master of *Trinity-house*, to be recommended to such, as are bound for far Sea-Voyages, and shall be judged fit for the performance: who are also to be desired, to keep an exact *Diary* of such observations and Experiments, and deliver at their return a fair Copy thereof to the Lord High Admiral of *England*, his Royal Highness the *Duke of York*, and another to *Trinity-house*, to be perused by the said *R. Society*.

The Particulars themselves follow :

- I. *To observe the Declinations and Variations of the Compass or Needle from the Meridian exactly, in as many Places as they can, and in the same Places, every several Voyage.*

AT Land, where by the help of good fixt Dials, and other fixt Instruments, the precise *Meridian* of the place may be known, it is easie to find the *Variation* of the *Needle*, divers ways: As, by applying of the *Needle*, &c. to the *Shadow* of a *Thread* hanging perpendicular, when the *Sun* is in the *Meridian*; or to the *Meridian Line*; or the *Side* of a fixt *Horizontal Dial*, &c.

But at *Sea*, in regard the *Meridian* is not so easie to be found to any tolerable exactness, to know the *Variation* of the *Needle*, is much more laborious and difficult. The *Height* of the *Pole*, and the *Sun's Declination* being known, a large *Ring-Dial*, truly wrought, having a *Box* with a *Compass* or *Needle* fixt to its *Meridian* below, may go as near as any other Instrument, to shew the *Variation* required. For, when it is set to the just hour and minute of the day, the *Meridian* of it stands just in its due place; and so shews how far the *Needle* varies from it, as exactly as the largeness of the *Card* will permit.

But because these *Dials* are so rarely just, &c. though they may be used and taken notice of, yet are they not to be relied on. The thing therefore is to be performed, as followeth:

Find out the *Sun's Azimuthal Distance* from the *Meridian* some hours before, or after *Noon*, and then its *Magnetical Azimuth*, or Distance from the *Meridian* pointed at by the *Needle*, and the Difference of these two Distances, is the *Variation* of the *Needle*.

To find the *Sun's true Azimuth*, or by how many Degrees, &c. of the *Horizon* it is distant from the *Meridian*: its *Declination*, its *Altitude*, and the *Elevation* of the *Pole*, must all three be known.

For finding whereof, every Expert Mariner is instructed, or may be so, from his Sea-Books, and so it needs not here to be set down. Nor how by the help of these, the *Azimuth* required may, to Degrees, if not nearer, be found out upon a good *Globe* or *Planisphere*, (whereof there is a design to have one, that is, the *Analemma*, contrived into a form of Instrument for the use of the publick, and that ere long; which will with great facility perform all that the *Globe* can do, with much more exactness and conveniency) that being sufficiently known.

But to do it accurately, you must constitute a *Spherical Oblique-angled Triangle*, of the three Complements, of the *Suns Declination*, its *Altitude*, and of the *Height of the pole*; the measures of all the Sides whereof are known; One from the *Zenith* to the *Pole*; another from the *Pole* to the *Point of the Suns Altitude*; and the third, from *that point to the Zenith*, Now by those you are to find out the Angle at the *Zenith*, which being found, subtract it from 180, and the remainder is the *Suns true Azimuth*, or Distance from the *Meridian* of the Place.

This Angle is to be found divers wayes, as by the *Tables of Sines, Logarithmes, &c.* the manners of doing whereof, are set down and demonstrated by *John Newton* in his *Institutio Mathematica*, Case II. and in other Books of *Trigonometry*.

And the true *Azimuth* of the *Sun* being thus found, and the *Magnetical Azimuth* of it, according to your Needle, observed, subtract the lesser Number from the greater, and the Remainder is the Variation of the Needle. If the *Magnetical Azimuth* be less than the other, then the Variation is towards the same side of the *Meridian*, where the *Sun* is; if greater, on the other.

To observe the *Suns Azimuth* by the Needle, and the Needles Variation to Degrees, any Needle, long enough to afford upon a Card under it, a Circle divided into Degrees, put in a Square Box, after the ordinary manner of *Clinatories*, will serve turn; by placing the Box so, as the *Sun* may shine upon any two opposite sides of it, at the same times that the *Suns Height, &c.* are taken: For then the Needles Distance from the Diameter of the Circle on the Card, that is parallel to those sides, is the *Magnetical Azimuth* required.

The same may be done with an ordinary *Sea Compass*, so it have a Circle towards the Limb of the Card, divided into Degrees, by fastening a small Thread, Lute-string or Wire (not of Iron) so upon it, as to pass just over the Center of that Circle; and placing a strait piece of wood or Brass-wire perpendicular on the edge of the Box at the end of the Thread, and turning it to the Sun, till the Shadow of it fall just upon the Thread: then observe, what Degree of the Circle on the Card the Thread cuts, by looking plum upon it; and that is the Suns *Magnetical Azimuth*.

But to have the *Variation* to *Degrees* and *Minutes* (which is most desirable) then the Observation last mention'd must be made with a *Quadrant*, *Sextant*, or some such other Instrument, so large as to admit of the division of a *Degree* into *Minutes*; which will require the *Radius* to be about three foot; the larger the better. If a *Quadrant*, then, it being laid flat, and the Square Box with the Needle placed upon it, move the *Quadrant* to and again, till that side of it, on which the Box is placed, lie parallel to the Needle, when at quiet: Then the *Sight* of the *Quadrant* being slid along the Rimb of it, till the Sun shine on both its sides at the same time, the Mid-Line, that divides equally the *Sight*, when the Sun shines upon it through the slit, will mark the Degree and Minute of the Suns *Magnetical Azimuth*. All which is easie to be put in-practice.

And if many such Observations be made by several persons at the same place, and by the same or other persons distant from one another, 1. 10. 20. or more Years; Not only will the Compass become more useful then formerly, even to be conducive possibly to the finding the Longitude at Sea, at least in some places: but the variation of the Variation of the Needle being known in different places, all will be reduced to Rules, and so from hence, Philosophical or Natural Knowledg, will probably be enlarged by a happy discovery of the true cause of the *Verticity*, or *Directive* faculty of the Loadstone; one of the *Noblest* and most *abstruse* *Phænomena*, that falls under the cognizance of humane Reason.

To find this variation by the Stars, is so easie, as every Master can do it; seeing there is no more requisite, than to find out the true *North*, that is the *Meridian*, and compare the Needles position

on with it. By this means, the variation may be had well enough to degrees, half degrees, and some smaller parts; and if carefully and curiously prosecuted, even to Minutes too. But it will not be amiss, to do it both by the Sun and Stars, that the greater certainty may be attained.

2. *To Carry Dipping-Needles with them.*

THe *Dipping-Needle* is to be used at least as frequently as the former Experiment is made, and in the same places, in order to the same purposes. All that needs be said of the Manner, is, that when the Dipping of the Needle is to be examined, the Circle, in which it moves, is to be hung perpendicular, and turned, till it be just in the *Magnetical Meridian*, where it dippeth most, and the degree of its depression under the *Horizon* is to be noted in a *Table*. See *Figure 1*.

3. *To mark carefully the Flowings and Ebbings of the Sea, in as many places as may be.*

THe Particulars here to be regarded, are, 1. The precise times of the beginnings of the Flood and Ebb, in all Rivers, Bayes, at Promontories, Capes, and in all Roads, Harbours, &c. 2. Which way Currents run in all places, with their Times, Changes, &c. 3. What perpendicular Distance there is, between the highest reach of the Tide, and lowest of the Ebb, both of all Spring-Tides and Neap-Tides, with their irregularities, &c. 4. What day of the Moon's age, and what times of the Year the highest and lowest Tides fall out: And all other considerable Accidents observable in Tides, chiefly in and near all Sea-ports, Harbours, Roads, Islands, &c. as *St. Helens Island, Bermudas*. 5. The position of the Wind at every Observation of the Tides, &c.

4. *To remark curiously the Situation, Figures, &c. of all dangerous Rocks, Sands, Channels, Entries, and Courses of Rivers, and all difficult Passages, and Courses in all places ; to measure and describe the same Exactly, their distances, bearings, &c. As also the Prospects of remarkable Coasts, Promontories, Ports, Islands, &c. in the same manner ; and make Draughts, Plots, and Maps of them, with their Longitudes, Latitudes, Scales, &c. and all Beacons, Buoyes, Landmarks, Light-houses, &c. which serve for directing the Course of Ships through narrow Channels, over Bars and Banks, into Rivers, Ports, Bayes, &c. And to sound Depths near all Coasts, in all shallow Places, Roads, &c.*
5. *To sound the deepest Seas without a Line, by the help of an Instrument, represented by Figure 2.*

TO perform this, take a Globe of *Fir*, or *Maple*, or other light wood, as *A*, let it be well secured by Vernish, Pitch, or otherwise, from imbibing Water, then take a piece of Lead or stone, *D*, considerably heavier, than will sink the Globe : Let there be a
long

long Wine-staple B in the Ball A, and a springing wire C, with a bended end F, and into the said Staple, press in with your fingers the springing Wire on the bended end : and on it hang the weight D, by its hook E, and so let Globe and all sink gently into the water, in the posture represented in the said *Figure*, to the bottom, where the weight D touching first, is thereby stopt ; but the Ball, being by the *Impetus* it acquired in descending, carried downwards a little after the weight is stopt, suffers the springing Wire to fly back, and thereby sets it self at liberty to re-ascend. And by observing the time of the Ball's stay under water (which may be done by a Watch, having Minutes and Seconds ; or by a good *Minute-Glass* ; or best of all, by a *Pendulum*, vibrating Seconds ; the which must be three foot, three inches, and one fifth of an inch long, *viz.* between the middle of the Bullet and the upper end of the Thread, where it is fastned, or held when it vibrates.) You may by this way, with the help of some *Tables*, come to know any depth of the Sea.

Note, That care must be had of proportioning the weight and shape of the *Lead*, to the bulk, weight, and figure of the *Globe*, after such a manner, as upon experience shall be found most convenient.

In some of the Trials already made with this Instrument, the Globe being of *Maple-wood*, well covered with Pitch, to hinder soaking in, was $5\frac{1}{16}$ inches in *Diameter*, and weighed $2\frac{1}{2}$ pounds ; the Lead, of $4\frac{1}{2}$ pounds weight, was of a *Conical* (but is now used of a *Globous*) Figure 11 inches long, with the sharper end downwards, $1\frac{1}{16}$ at the bottom in *Diameter*. And in those Experiments made in the *Thames*, in the depth of 19 foot water, there passed between the Immersion and Emerision of the Globe, 6 Seconds of an hour ; and in the depth of 10 foot water, there passed $3\frac{1}{2}$ Seconds, or thereabouts : From many of which kind of Experiments, it will likely not be hard to find out a method to calculate, what depth is to be concluded from any time of the like *Globes* stay under water : As for instance, if in the depth of 20 fathom, measured by the Line, the Globe stay under water 15 Seconds ; then if the Ball stay 600 Seconds, the depth of the Sea is 933 fathom and 2 foot, if the Ball be found to move equal spaces in equal time.

In the same Trials made with this Instrument in the said River of *Thames*, it has been found, that there was no difference in time, between the submersions of the Ball at the greatest depth, when it rose two Wherry's length from the place where it was let fall (being carried by the Current of the Tyde) and when it rose onely a Yard, or so, from the same place, where it was let down: And that it must be so in great depths and stronger Currents, is as certain, as easie to be demonstrated.

And if it be alledged, that it must be known, when a *Light Body* ascends from the bottom of the Water to the Top, in what proportion of time it rises; it may be considered, that in this Experiment the times of the Descent and Ascent are both taken and computed together; so that, for this purpose, there needs not the nicety, which is alledged.

OF other Experiments of this way of sounding without a Line, made by the Noble Lord Viscount *Brounker*, Sir *Robert Moray* Knight, and Mr. *Hook*, in the Channel at *Sheernefs*; the following account was given, *Vid.*

<i>Weighed</i>	<i>Ounce. Grains.</i>
A Wooden Ball (A)—————	32 $\frac{2}{16}$ 00
Another Wooden Ball (B)———	30 22
A Lead (A)—————	30 00
Another Lead (B)—————	30 $\frac{1}{4}$ 00

The Ball (B) and the Lead (B) were let down at 16 fathom; and the Ball returned in 48 single strokes of a *Pendulum*, held in the hand, vibrating 58 single strokes in a *Minute*.

A second time repeated with the same success; therefore, the motion was 4 foot every second.

Again the Ball (A) and the Lead (B) whose Nail was bended into a sharper Angle; the Ball returned in 39 strokes. A second time repeated with the same success at the same depth.

Ball (B) Lead (B:) in which trial the Line, not being clear, stopped a little the motion; the Ball returned in 47 at the same depth.

M m m

Ball

Ball (A) Lead (A) at 8 fathom and 1 foot, returned at 20;
repeated at 8 fathom, returned at 19.

Tried the third time at 10 fathom and 4 foot, return'd at 28.

A fourth Trial, at the same depth, just the same.

A fifth, at 10 fathom, 5 foot, returned in 27.

A sixth Trial, just the same.

A seventh, at 12 fathom, 5 foot returned in 37.

An eighth Trial, just the same,

Another Day, near the same place.

Note, That the *Pendulum* was this Day adjusted, and made a little shorter, there having been but 58 vibrations in a *Minute*, the other day.

Ball (A) Lead (B) at 14 fathom, returned in $32\frac{1}{2}$.

A second Trial, a little after in the same place, returned in 33. In making of which Trial, the Vibrations were told aloud, and the Lead having been let down by a Line, was found to touch the bottom in just half the time, the Ball staid under water. By a second Trial, the ascending and descending was found to be in equal times. And by a third Trial with another Lead, the very same found, *vid.* $16\frac{1}{2}$ descending, and $16\frac{1}{2}$ ascending. This Lead and Ball let down without a Line, the Ball returned in 13 vibrations; a sign it went not to the bottom.

A Trial made with a Lead, whose *Iron-Crook* was fasten'd at the top of it (like that in the *Figure 3*) succeeded very well, and the Ball returned in $34\frac{1}{2}$: But by reason of the Current, the Experimenters could not perceive, when the Lead touched the bottom. This Lead being let down without a Line, the Ball returned in $32\frac{1}{2}$. The depth of the water was now found by the Ships Lead, to be 14 fathom.

Another Trial was made with a Line, bowing the point of the Lead (like that in the *Fig. 4*) and the Ball return'd in 34. The same let down without a Line, the Ball return'd in 6 or 7 vibrations; a sign again, it went not to the bottom.

In a Trial with another Lead, the Ball return'd in 34.

Repeated again with the same success.

In a Trial with a Lead, whose Nail was set awry (like that of the *Fig 5.*) the Ball returned in 34. After which Trial the depth was found to be just 14 fathom.

The last Lead and Ball being let down without a Line, the Ball returned at 35.

In another Trial with a Lead that never failed, the Ball returned in 34, and the Lead toucht the bottom at 17.

By a Trial with another Lead, the same time was found exactly.

By a third Trial with this last, the very same.

These Trials were made near about High-water, at the depth of 14 fathom just by measure: And in them, the motions seem to be 5 foot every second.

In all these Trials, the greatest difficulty was, in the use of Conical Figures, with Iron Crooks, to bend the Iron, that it might be sure to carry down the Ball with it to the bottom, and when come thither, to let it go: for almost every one of these Leads failed in one of these requisites, till by several Trials they had been adjusted.

It is not to be omitted, That the last Trials being made near High-water, the Ball was found to rise (by the Boat, being permitted to drive) far off upon one side, out of the way, that any light thing, suffered to swim on the water, would be carried; which seemed to argue a motion of the under parts of the water, differing from that of the upper (a thing which is said to beat certain times of the Tydes, both at the Mouth of the *Sound*, and of the *Streights*; which deserves to be further inquired into.) The Angle made by these different motions, seemed to be about 40 Degrees.

6. *To keep a Register of all changes of Wind and Weather at all hours by Night and by Day, shewing the point the Wind blows from, whether strong or weak : The Rains, Hail, Snow, and the like ; the precise times of their beginnings and continuance ; especially Hurricans and Spouts; but above all to take exact care to observe the Trade-Winds, about what degrees of Latitude and Longitude they first begin, where and when they cease or change, or grow stronger or weaker, and how much ; as near and exact as may be.*

THe strength of the winds is measured by an Instrument, such is represented ; by *Figure 6* ; which being exposed to the Wind, so as the flat side may be right against it, the number of *Degrees* upon the *Limb A B*, to which the Wind blows up, or raises, that flat side *C D*, shews the force or strength of the Wind, in proportion to the resistance of the flat side of the Instrument ; and is to be recorded.

The

The Form of a Scheme.

Which at one view represents to the Eye Observations of the Weather, for a whole Month, may be such, as follows.

Days of the Month, and Place of the Sun	Remarkable hours.	Age and Sign of the Moon at Noon.	The Quarters of the Wind, and its strength.	The Faces or visible appearances of the Sky.	The Notable Effects	General Deductions.
June 14 II 12.46'	4 8 12 4 8 12	27 9. 46 Perigeeum	W --- 2 ----- 3 ----- 3½ ----- WSW I	Clear blue, but yellowish in the N E. Clouded toward the South. Checkered blue.	A great Dew Thunder far to the S. A very great Tyde.	From the last Quarter of the Moon to the Change, the weather was very temperate, but for the Season, cold; the Wind pretty constant between N. and W. &c.
15 II 13.40'	8 4 6 12	28 24.5 I N	N W 3 4 2 I	A clear sky all day, but a little checkered about 4 P. M. At Sun-set red and hazy.	Not by much so big a Tyde as yesterday. A great Thunder-Showre from the N.	
16 II 14.57 &c.	10 12	New Moon at 7. 25. A. M. II 10.8 &c.	S &c.	Overcast and very lowring, &c.	No dew upon the ground, but very much upon Marble-stones, &c.	

7 *To observe and record all Extraordinary Meteors, Lightnings, Thunders, Ignis fatuos, Comets, &c. marking still the places and times of their appearing, continuance, &c.*

8. *To carry with them good Scales and Glass-Viols of a pint or so, with very narrow mouths, which are to be fill'd with Sea-water in different degrees of Latitude, and the weight of the Viol full of water taken exactly at every time, and recorded; marking withall the degrees of Latitude and Longitude of the Place, and the Day of the Month, and the Temperature of the Weather: And that as well of Water near the Top, as at a greater Depth.*

THe Viol is to be made with a very narrow Neck, and when it is almost full, water is to be dropt into it, drop by drop, till it can hold no more, drying well the Viol before it be weighed. The weight of the empty Viol is also to be recorded every time, weighing all to grains. And by evaporating gently the water, till the Salt be left dry on the bottom; they, who list, may have the satisfaction to know, what proportion the Salt of each water holdeth to its weight.

There is, among some other ways of finding the different gravities of Water, a very pretty one, mentioned by some Authors, as *Johannes Toldenus* (a German Artist) *Cabeus*, and *Kircher* in his

his *Fundus subterræ*, and improved and first brought into use here, divers years agoe, by the Noble *R. Boyle*, who also, as himself informed the Publisher, hath in some of his Writings, yet unpublisht, set down a full Description thereof.

It is such a Glass-Tube as is represented by *Fig. 7.* blown at a Lamp, and poised in good common Water by putting *Quick-silver* into it, until it sink so low, that nothing appear above the Superficies of the Water, but the Top; which done it is to be sealed up, and to be graduated on its side, into what parts you please; which may be done with a Diamond. And then, being put into any Water to be weighed, it will, by its more or less sinking into it, shew the differences of the Waters gravity.

9. To fetch up Water from any Depth of the Sea.

TO perform this, let there be made a *Square Wooden Bucket* (such as *C* in *Fig. 8.*) whose bottoms *EE* are to be so contrived, that the weight *A* do sink the Iron *B* (to which the *Bucket C* is fastned by two Handles *DD*, on the ends of which are the moveable bottoms or Valves *EE*) and thereby draws down the *Bucket*, the resistance of the Water keeps up the *Bucket* in the posture *C*; whereby the Water hath a clear thorow-passage all the while it is descending: whereas as soon as the *Bucket* is pulled upwards by the Line *F*, the resistance of the Water to that motion, beats the *Bucket* downward, and keeps it in the posture *G*; whereby the included Water is preserved from going out, and the Ambient Water kept from getting in.

By the advantage of which Vessel, or such like, you may come to know the *Degrees of Saltiness* of Sea-Water, according to its nearness to the Top or Bottom; or rather, the Constitution of the Sea-Water in several Depths of several *Climates*: Likewise, whether in some places of the Sea, there be any sweet Water at the Bottom; the *Affirmative* whereof is to be met with in the *East-Indian Voyages* of *Van Linschoten*, who pag. 16 of that Work, as 'tis *Englished*, records, that in the *Persian Gulf*, about the Isle of *Baharem*, they fetch up with certain Vessels (which he de-

describes not) Water out of the Sea, from under the Salt-Water, four or five fathom deep, as sweet as any Fountain-water, And since 'tis argued by some, that such Sweet-water proceeds from certain Sweet Water-Springs, that were formerly on the Continent, at some distance from the Sea, and came afterwards to be covered by the Sea ; it may be presumed, that in other places we may find the like. Besides, we know not, but that there may be in many parts, Eruptions of large Springs at the Bottom of the Sea, that were never taken in by any of its encroachments.

These Experiments are to be repeated every New Voyage, the multitude and frequency of them being necessary for finding out and confirming the truth of them; which as it will conduce exceedingly to the Enlargement of Natural Knowledge, so it may in time produce New and more accurate Sea-Maps and Cards, than hitherto have been published; and great helps and advantages to Navigation: especially those of the Variation, and Dipping of the Needle; the Depth and Saltness of the Water; the Nature of the Ground at the Bottom of the Sea; and indeed almost every one of the rest; there being a Design to consider all, and to draw out of them such Rules and Directions, as may bring no less Honour, than Benefit to the English Nation.

The Instruments, described and represented in these Papers, may be had from Mr. Richard Shortgrave, Operator to the R. Society, to be found at Gresham Colledge; who also will be ready, if there be occasion, to give more particular Directions for the use of the same.

ADVERTISEMENT.

IT is desired by Christopher Merret M. D. to inform the Publick, that within the space of four Months, he shall re-publish his Pinax Rerum Naturalium Britannicarum, with many additions, and in his proposed New Method; and that he wholly disclaims the Second Edition of that Book, as being printed and published without his knowledge.

In the SAVOR,
Printed by T. N. and John Martin at the Bell, a little without Temple-Bar, for James Allestry in Duck-Lane, Printers to the Royal Society, 1667.

Fig. 1.

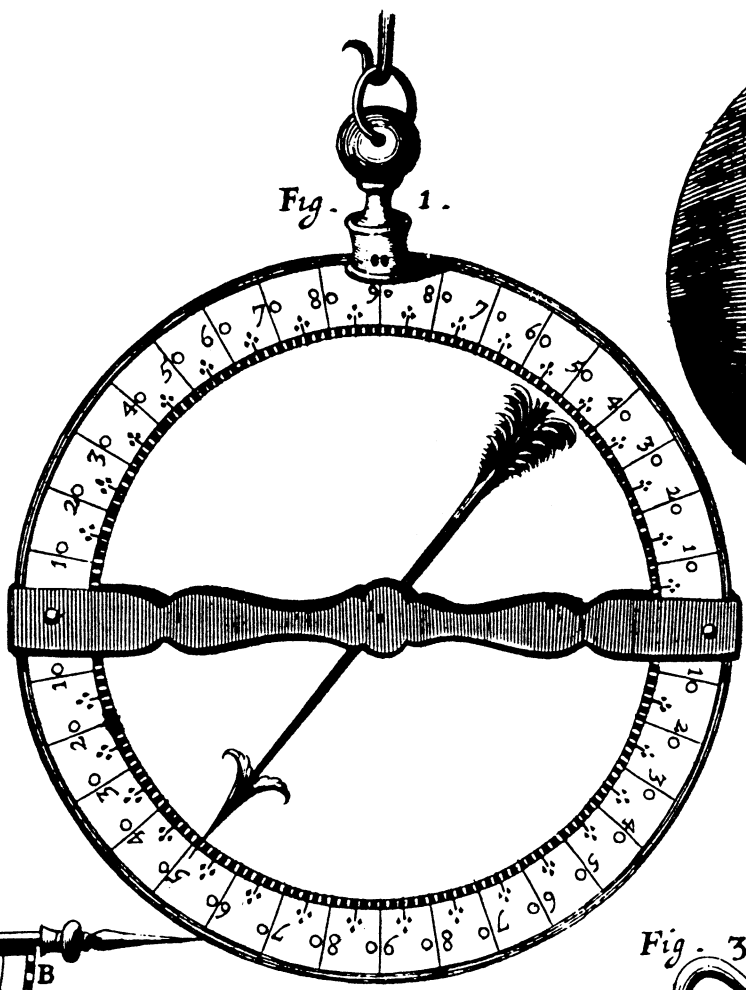


Fig. 2.

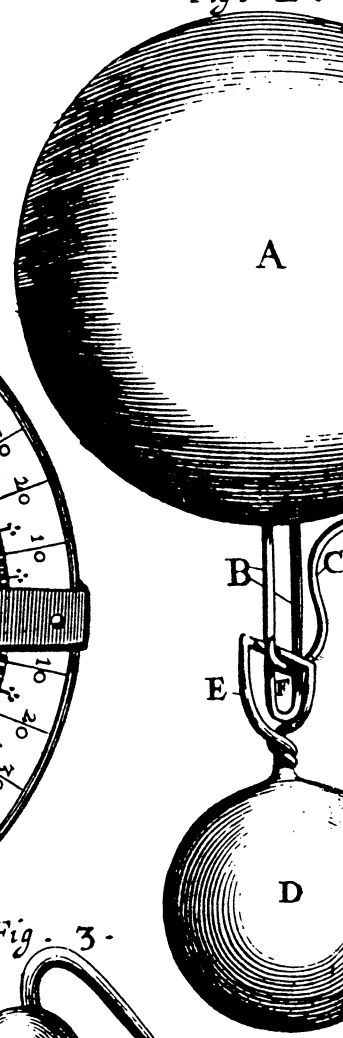


Fig. 6.

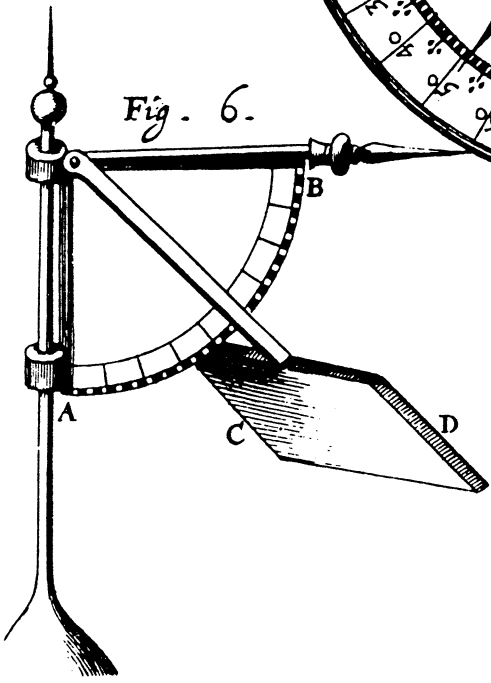


Fig. 3.

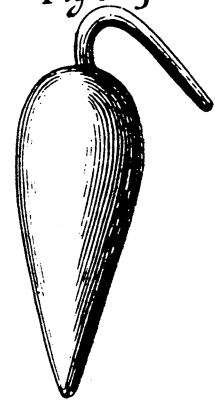


Fig. 4.



